

Producing Visible Light

Objectives

After this lesson, students will be able to
0.3.3.1 Describe the different types of light bulbs.

Target Reading Skill

Comparing and Contrasting Explain that comparing and contrasting information shows how ideas, facts, and events are similar and different. The results of the comparison can have importance.

Answers

Ordinary light bulb: bulb made of glass, gets hot, has a tungsten filament and nitrogen gas and argon gas inside, is not efficient;
Tungsten-halogen bulb: bulb made of quartz, gets very hot, has a tungsten filament and a halogen gas inside, is more efficient than an ordinary light bulb; *Fluorescent light:* bulb made of glass, stays cool, has a gas and a powder coating inside, is very efficient; *Vapor light:* has neon or argon gas and solid sodium or mercury inside, is very efficient; *Neon light:* bulb made of glass, has neon gas inside

All in One Teaching Resources

- [Transparency O34](#)

Preteach

Build Background Knowledge

L2

Properties of Ordinary Light Bulbs

Use students' prior knowledge to introduce properties of light sources. Ask: **If a 100-watt light bulb that has been on for a while suddenly burned out, would you immediately unscrew it?** (No; you would wait for it to cool down.) **Do all light bulbs get hot?** (Sample answer: Fluorescent lights do not.) Tell students they will learn about five types of light bulbs in this section.

Producing Visible Light

Reading Preview

Key Concept

- What are the different types of light bulbs?

Key Terms

- illuminated
- luminous
- spectroscope
- incandescent light
- tungsten-halogen bulb
- fluorescent light
- vapor light
- neon light

Target Reading Skill

Comparing and Contrasting

Compare and contrast the five types of light bulbs by completing a table like the one below.

Light Bulbs		
Feature	Ordinary Light Bulb	Tungsten-Halogen
Bulb material	Glass	
Hot/Cool		

Lab Zone

Discover Activity

How Do Light Bulbs Differ?



1. Your teacher will give you one incandescent and one fluorescent light bulb.
2. Examine the bulbs. Record your observations and describe any differences. Draw each type of bulb.
3. How do you think each bulb produces light?

Think It Over

Posing Questions Make a list of five questions you could ask to help you understand how each bulb works.

Look around you. Most of the objects you see are visible because they reflect light from some kind of light source. An object is **illuminated** if you see it by reflected light. The page you are reading, your desk, and the moon are examples of illuminated objects. An object is **luminous** if it gives off its own light. A light bulb, a burning log, and the sun all are examples of luminous objects.

Different types of light bulbs may be used to illuminate the spaces around you. **Common types of light bulbs include incandescent, tungsten-halogen, fluorescent, vapor, and neon lights.** Some light bulbs produce a continuous spectrum of all of the wavelengths of visible light. Others produce only a few wavelengths. You can use an instrument called a **spectroscope** to view the different colors of light produced by a light bulb.



Incandescent Lights

Have you heard the phrase “red hot”? When a glassblower heats glass, it glows and gives off red light. At a higher temperature, it gives off white light and the glass is said to be “white hot.” An **incandescent light** (in kun DES unt) is a light bulb that glows when a filament inside it gets white hot. Thomas Edison, the American inventor, patented the first practical incandescent light bulb in 1879.

◀ Glassblower working with heated glass

Lab Zone

Discover Activity

Skills Focus Posing questions

Materials clear (uncoated) incandescent light bulb, fluorescent light bulb, goggles

Time 10 minutes

Tips Students must avoid breaking the glass bulbs, and advise you immediately if a bulb breaks. Wear gloves and follow appropriate procedures for cleaning up broken glass.

L1

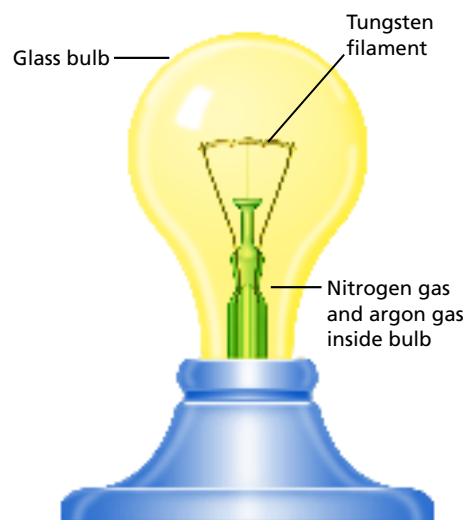
Expected Outcome Students might describe differences in the shape or size of the bulbs or might know that an ordinary light bulb produces light when the wire inside it glows.

Think It Over Questions will vary. Sample question: What substance gives off the light?

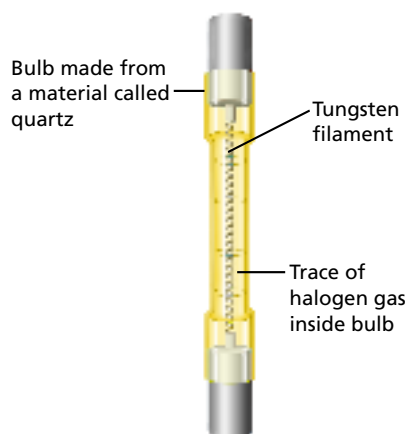
FIGURE 9

Incandescent Lights

A filament glows when electric current passes through it. **Comparing and Contrasting** How are ordinary light bulbs like tungsten-halogen bulbs? How are they different?



Ordinary Light Bulb



Tungsten-Halogen Bulb

Ordinary Light Bulbs Look closely at the ordinary light bulb shown in Figure 9. Notice the thin wire called the filament. It is made of a metal called tungsten. When an electric current passes through the filament, it quickly heats up and becomes hot, giving off white light. The filament is enclosed in an airtight glass bulb. Most ordinary light bulbs contain small amounts of nitrogen and argon gases.

Ordinary light bulbs are not efficient. Less than 10 percent of their energy is given off as light. Most of their energy is given off as infrared rays. That's why they get so hot.

Tungsten-Halogen Bulbs A bulb that has a tungsten filament and contains a halogen gas such as iodine or bromine is called a **tungsten-halogen bulb**. The filament of this bulb gets much hotter than in an ordinary light bulb, so the bulb looks whiter.

Tungsten-halogen bulbs are more efficient than ordinary bulbs because they give off more light and use less electrical energy. But they also give off more heat. Because tungsten-halogen bulbs get so hot, they must be kept away from materials that could catch fire.



What gases are used in tungsten-halogen bulbs?

Lab zone Skills Activity

Observing

Use a spectroscope to view light from two sources.

CAUTION: Do not view the sun with the spectroscope.

1. Look through the spectroscope at an ordinary light bulb. Use colored pencils to draw and label what you see.
2. Now, look at a fluorescent light through the spectroscope. Again, draw and label what you see.

How are the colors you see the same? How are they different?

Instruct

Incandescent Lights

Teach Key Concepts

L2

Comparing and Contrasting Types of Incandescent Lights

Focus State that an incandescent light is a light bulb that glows when a thin wire inside it, called a filament, becomes so hot that it glows white.

Teach Tell students that there are two common types of incandescent light bulbs: ordinary light bulbs and tungsten-halogen light bulbs. Draw a Venn diagram on the board to compare and contrast the two types of incandescent light bulbs. For example, both have a tungsten filament and produce white light; but ordinary bulbs are made of glass and have low efficiency, whereas tungsten-halogen bulbs are made of quartz and have medium efficiency.

Apply Tell students that tungsten-halogen lights become even hotter than ordinary lights. Ask: **How might that be a drawback or limitation of tungsten-halogen lights?** (Sample answer: It might limit where they can be safely used, because they must be kept away from materials that could catch fire.) **learning modality: verbal**

All in One Teaching Resources

- [Transparency O35](#)

Independent Practice

L2

All in One Teaching Resources

- [Guided Reading and Study Worksheet: Producing Visible Light](#)



Student Edition on Audio CD

Monitor Progress

L2

Writing Have students write a paragraph explaining how electric current produces light in ordinary light bulbs and in tungsten-halogen light bulbs.

Answers

Figure 9 Both have a tungsten filament inside a bulb that contains gases. The bulbs differ in shape, the material they are made of, and the gases they contain.



A halogen gas, such as iodine or bromine

Lab zone Skills Activity

Skills Focus Observing

Materials spectroscope, ordinary light bulb, fluorescent light bulb, colored pencils

Time 15 minutes

Tips Before the activity, explain how fluorescent lights produce light. Demonstrate the spectroscope.

L3

Expected Outcome The incandescent spectrum will be continuous; the fluorescent spectrum will have distinct colored lines.

Extend Explain that the bands of color are not the same because the two types of light bulbs give off light of different wavelengths. Encourage interested students to examine other types of lights. **learning modality: kinesthetic**

Other Light Sources

Teach Key Concepts

L2

Introducing Other Light Sources

Focus Introduce the three other light sources covered in this section: fluorescent lights, vapor lights, and neon lights.

Teach State that a basic difference between incandescent light bulbs and these other types of light bulbs is the part of the bulb that gives off light. Remind students that a metal wire inside incandescent light bulbs gives off light. Explain that in the other three types of light bulbs, either a powder coating the inside of the bulb or gas inside the bulb gives off light. Ask: **What type of gas do you think gives off light in a neon light?** (*Neon*) **In a sodium vapor light?** (*Sodium*)

Apply Ask: **How might this difference between incandescent and other types of light sources affect their performance?** (*Students might predict that the other types of lights are cooler or more efficient or that they produce light of different colors.*) **learning modality: verbal**

Integrating Life Science

L2

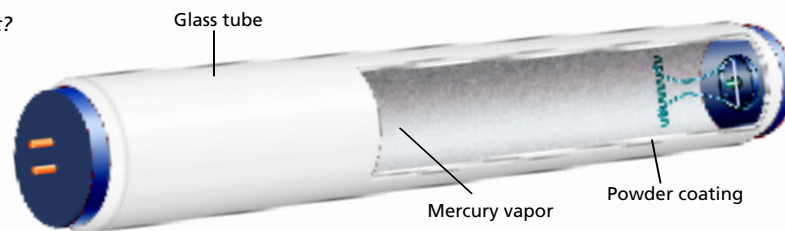
Inform students that some organisms can produce light and “glow in the dark.” State that the ability of an organism to produce light is called *bioluminescence*. Write the word on the board so students can see how it is spelled. Explain that the light is produced when a chemical reaction takes place. The reaction involves phosphorus, which is also contained in the head of matches. State that bioluminescence may be used by an organism to attract prey or to attract a mate. Then, ask: **What are some examples of organisms that are bioluminescent?** (*Sample answer: Fireflies, some species of fish*) Mention that certain species of bacteria and algae are also bioluminescent. Point out that most bioluminescent organisms are active after dark, in deep water, or in other environments where there is very little light.

learning modality: verbal

FIGURE 10

Fluorescent Light

A fluorescent light is cool because very little energy is given off as infrared rays. **Inferring** Why is a fluorescent light efficient?



Other Light Sources

Incandescent light bulbs are not the only light bulbs you see around you. Some spaces are lit by fluorescent lights. Streets and parking lots may be lit with vapor lights. Neon lights are often used to attract attention to stores and theaters.

Fluorescent Lights Have you ever noticed long, narrow glass tubes that illuminate schools and stores? These are fluorescent light bulbs. A **fluorescent light** (floo RES unt) is a bulb that contains a gas and is coated on the inside with a powder. When an electric current passes through the bulb, it causes the gas inside to give off ultraviolet rays. When the ultraviolet rays hit the powder in the tube, the powder gives off visible light.

Fluorescent lights give off most of their energy as visible light and only a little energy as infrared rays. Therefore, fluorescent lights do not get as hot as incandescent light bulbs. They also usually last longer than incandescent lights and use less electrical energy for the same brightness. So, fluorescent lights are very efficient.

Vapor Lights A bulb that contains neon or argon gas and a small amount of solid sodium or mercury is a **vapor light**. When an electric current passes through the gas, the gas heats up. The hot gas then heats the sodium or mercury. The heating causes the sodium or mercury to change from a solid into a gas. In a sodium vapor light, the particles of sodium gas glow to give off a yellowish light. A mercury vapor light produces a bluish light.

Both sodium and mercury vapor lights are used for street lighting and parking lots. They require very little electrical energy to give off a great deal of light, so they are quite efficient.

FIGURE 11

Sodium Vapor Lights

Sodium vapor lights give off a yellowish light.



Differentiated Instruction

Less Proficient Readers

Comparing and Contrasting Guide students in making a graphic organizer, such as a Venn diagram, to compare and contrast fluorescent lights, vapor lights, and neon lights. Suggest that students compare and contrast how these lights produce visible light and how efficient they are. **learning modality: visual**

L1

Special Needs

Observing Different Light Sources Point out different types of light bulbs in the school. There might be fluorescent lights in the classroom, neon lights in the cafeteria, and vapor lights in the parking lot. Suggest that students note the size and shape of the bulbs, the color of light they produce, and how bright they are. **learning modality: visual**

L1

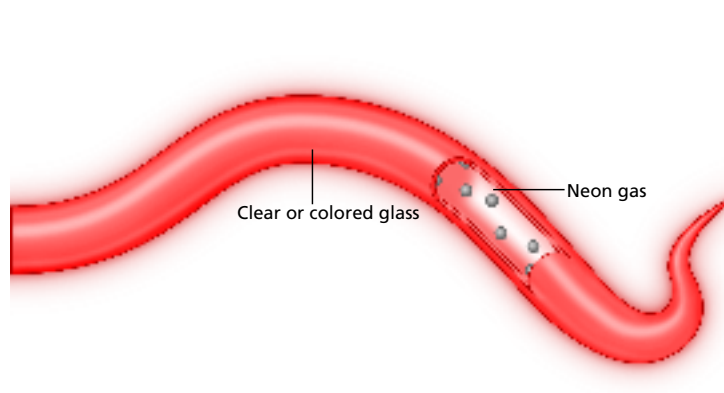


FIGURE 12
Neon Lights
The color of a neon light depends in part on which gas or gases are in the tube.

Neon Lights A **neon light** is a sealed glass tube that contains neon gas. When an electric current passes through the neon, particles of the gas absorb energy. However, the gas particles cannot hold the energy for very long. The energy is released in the form of light. This process is called electric discharge through gases.

A true neon light gives off red light, as shown in Figure 12. But often, lights that contain different gases or a mixture of gases are also called neon lights. Different gases produce different colors of light. For example, both argon gas and mercury vapor produce greenish-blue light. Helium gives pink light. Krypton gives a pale violet light. Sometimes colored glass tubes are used to produce other colors. Neon lights are commonly used for bright, flashy signs.



What color of light does a neon light give off?

Section 3 Assessment

Target Reading Skill Comparing and Contrasting Use the information in your table about light bulbs to help you answer Question 1 below.

Reviewing Key Concepts

1. **a. Listing** What are five common types of light bulbs?
- b. Explaining** How do incandescent light bulbs work?
- c. Inferring** Lamps that use ordinary light bulbs often have cloth or paper shades. But tungsten-halogen lamps usually have metal shades. Explain.
- d. Making Generalizations** What gives off light in incandescent light bulbs? What gives off light in other types of light bulbs?



At-Home Activity

Buying Light Bulbs Invite family members to visit a hardware store. Ask a salesperson to describe the different kinds of light bulbs available. Read the information about each bulb on the packages. Look for the cost and the expected life of the bulbs. How does this information help you and your family to choose bulbs for different purposes?



At-Home Activity

Buying Light Bulbs **L2** Encourage students to describe to their family how the different types of light bulbs work. Ask students to state the criteria they used to choose the most economical bulb.

Monitor Progress L2

Answers

Figure 10 A fluorescent light is efficient because it gives off most of its energy as visible light and only a little as infrared rays. It lasts longer than an incandescent light bulb and uses less electricity for the same brightness.



A neon light gives off red light.

Assess

Reviewing Key Concepts

1. **a.** Ordinary incandescent bulbs, tungsten-halogen bulbs, fluorescent, vapor, and neon lights **b.** When an electric current passes through the filament, it becomes white hot, giving off white light. **c.** Tungsten-halogen lamps usually have metal shades, because they get hotter than ordinary light bulbs and might set cloth or paper shades on fire. **d.** In incandescent light bulbs, the filament gives off light. In fluorescent lights, the powder coating of the bulb gives off light. In vapor lights and neon lights, a gas gives off light.

Reteach L1

List the five types of light bulbs on the board. Ask each student to state a fact about one of the five bulbs. Go around the room until every student has been called on or until students can no longer identify new facts. If students make errors, give them another chance or pass on to another student.

Performance Assessment L2

Skills Check Read the sentence(s) describing how light is produced in each of the five types of bulb, and have students identify which type of bulb it is.

All in One Teaching Resources

- [Section Summary: Producing Visible Light](#)
- [Review and Reinforcement: Producing Visible Light](#)
- [Enrich: Producing Visible Light](#)

Comparing Light Bulbs

Prepare for Inquiry

Key Concept

Different types of light bulbs can be used to provide light for different purposes.

Skills Objective

After this lab, students will be able to

- infer which light bulb gives the most illumination based on their observations
- interpret their data to identify factors that affect a light bulb's illumination
- draw conclusions about whether the most expensive light bulb is best



Prep Time 15 minutes

Class Time 40 minutes

Advance Planning

Purchase a variety of incandescent light bulbs that fit the same socket. You might include “soft white” bulbs, clear glass bulbs, standard-life bulbs, long-life bulbs, and, within each type, bulbs with different power, such as 40-watt, 60-watt, and 75-watt bulbs. Provide each student team with a light socket and a cardboard box about the size of the box in the picture. Make sure the other materials are on hand.

Safety



Remind students that light bulbs must be allowed to cool for several minutes before they are unscrewed. Make sure students unplug the lamps or sockets before they change bulbs. Advise students to tell you immediately about any broken bulbs. Review the safety guidelines in Appendix A.

All in One Teaching Resources

- Lab Worksheet: [Comparing Light Bulbs](#)

Guide Inquiry

Invitation

Show students several light bulbs and their packages. Explain what the wattage rating and life expectancy rating mean. Ask: **What types of light bulbs do you use at home?** (*Students are likely to identify one or more types from those on display.*) Urge students to think about where and when they use the different types of light bulbs.

Comparing Light Bulbs

Problem

Which types of light bulbs provide the best illumination?

Skills Focus

inferring, interpreting data, drawing conclusions

Materials

- a variety of incandescent light bulbs that can fit in the same lamp or socket
- medium-sized cardboard box
- light socket or lamp (without shade)
- meter stick
- wax paper
- scissors
- plain paper
- tape

Procedure



1. Following the instructions below, construct your own light box. The box allows you to test the illumination that is provided by each light bulb.
2. Make a data table like the one shown to record your data.
3. With a partner, examine the different bulbs. What is the power (watts), light output (lumens), and life (hours) for each bulb? Predict which light bulb will be the brightest. Explain your choice.
4. How will you test your prediction? What kinds of incandescent light bulbs will you use? What variables will you keep constant? What variables will you change?
5. Review your plan. Will your procedure help you find an answer to the problem?
6. Ask your teacher to check your procedure.
7. Before you repeat the steps for a second light bulb, look back at your procedure. How could you improve the accuracy of your results?
8. Test the illumination of the rest of your light bulbs.

How to Build and Use a Light Box

- A Use a medium-sized cardboard box, such as the kind of box copy paper comes in. If the box has flaps, cut them off.
- B Carefully cut a viewing hole (about 2 cm x 4 cm) in the bottom of the box. This will be on top when the box is used. This is hole A.
- C Punch another hole (about 1 cm x 1 cm) on one side of the box. This is hole B. It will allow light from the bulb to enter the box.
- D To decrease the amount of light that can enter, cover hole B with two layers of wax paper.
- E Put one of your light bulbs in the lamp and place it at the side of the box, about 1 m from hole B
- F Have your partner write a secret letter on a piece of plain paper. Put the paper on the table. Place the light box over the paper with the viewing hole facing up.
- G Now look through hole A. Turn the lamp on and move the light toward the box until you can read the secret letter. Measure the distance between the light bulb and hole B.

Introduce the Procedure

Have students read through the procedure. Suggest that each team limit its comparison to light bulbs that differ in just one variable. For example, a team might compare regular-life and long-life light bulbs of the same power, such as 40 watts. Another team might compare 40-watt and 75-watt light bulbs of the same type, such as clear glass.

Troubleshooting the Experiment

- The same student should do all the viewing for each team to reduce observer error.
- Remind students to wait for their eyes to adjust to the light before making observations and to avoid looking directly at the light.

Data Table						
Bulb Number	Brand Name	Power (watts)	Light Output (lumens)	Life (h)	Cost (dollars)	Distance From Bulb to Light Box (cm)

Analyze and Conclude

- Observing** How does the distance between the bulb and hole B affect how easily you can read the secret letter?
- Inferring** Based on your observations, what can you infer about the illumination provided by each bulb? Which bulb gave the most illumination?
- Interpreting Data** How did your results compare with your prediction? What did you learn that you did not know when you made your prediction?
- Interpreting Data** What factors affect the illumination given by a light bulb?
- Drawing Conclusions** Based on your results, do you think that the most expensive bulb is the best?
- Communicating** Using what you have learned, write an advertisement for the best light bulb. Explain why it is the best.

Design an Experiment

A lighting company claims that one of their 11-watt fluorescent bulbs gives off as much light as a 75-watt ordinary light bulb. Design an experiment to test this claim. *Obtain your teacher's permission before carrying out your investigation.*

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Sample Data Table

Bulb#	Brand Name	Power (watts)	Light Output (lumens)	Life (hrs)	Cost (\$)	Distance from bulb to Light Box (cm)
1	A, soft-white	75	1,170	750	1.89	43
2	B, long-life	75	1,125	1,125	2.59	42
3	C, discount	75	1,170	1,000	.99	39
4	D, soft-white	60	860	1,000	1.68	30
5	E, fluorescent	15	860	10,000	4.05	53

Expected Outcome

Students should use their data to draw a conclusion about which type of light bulb provides the best illumination. Results will vary depending on the light bulbs students compared.

Analyze and Conclude

- The closer the bulb is to hole B, the easier it is to read the secret letter.
- Answers will vary depending on the light bulbs students compared. The bulb with the greatest distance measurement produces the greatest illumination.
- Answers will vary depending on students' predictions. Students may learn that bulbs with higher wattages generally produce greater illumination. Students may also find that, at the same wattage, different bulbs may vary in the amount of illumination they produce. For example, long-life bulbs emit a little less light than normal-life bulbs of the same wattage.
- Factors include wattage, life expectancy, and whether it is incandescent or fluorescent.
- Answers may vary depending on the light bulbs compared. Students might conclude that the most expensive light bulb is best if it has the greatest light output or longest life.
- Advertisements should describe how the chosen light bulb surpasses the other light bulbs tested.

Extend Inquiry

Design an Experiment Students might use the same experimental design as in this lab and compare an 11-watt fluorescent light bulb with a 75-watt ordinary light bulb. Give interested students a chance to carry out the investigation.

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